

# **SWAMSI Cymbals Projector**

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## **LONG TERM GOAL**

To design, fabricate and deliver two cymbal projectors for MIT 21" BlueFin vehicles in support of the SWAMSI program.

## **OBJECTIVE**

To provide two broadband acoustic projectors that can be placed within two MIT BlueFin test vehicles and provide acoustic output over the band of 1 kHz through 20 kHz.

## **APPROACH AND WORK COMPLETED**

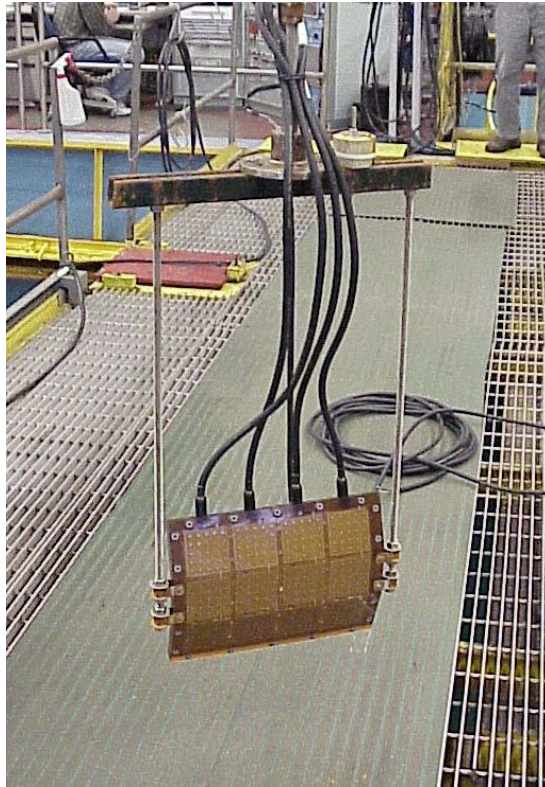
The design of these projectors is similar to that done for the NRL BMIS system and commonality of parts and fabrication tooling and techniques have been used. In early FY07, the projector of the first deliverable system was electroacoustically evaluated. The accompanying electronics package for this system was completed in January 2007 and delivered to MIT in March 2007. A second system was ordered in FY07 for use on a second vehicle. The projector array was completed in June 2007. The electronics for this array are presently in procurement with an expected December 2007 completion.

Technical support was provided by Kim Benjamin and Dr. Dehua Huang of NAVSEADIVNPT. Fabrication was provided by Scott Small and Derek Lengacher of NSWC-Crane. Measurements were provided by Rene LeFleur, Hugo Mendoza and Walter Boober of NAVSEADIVNPT.

## **RESULTS**

A photograph of the first completed array is shown in Fig. 1 as it was mounted for electroacoustic testing in October 2006. Fig. 2 is a plot of the measured transmitting voltage response where all four of the staves are electrically tied together in parallel. Note that this measurement shows that the desired low frequency resonance has been lowered to 1.2 kHz. The measured directivity patterns showed excellent agreement for those expected from a rectangular piston source of the same radiating dimensions. The array was tested in a free field, unbacked condition where upon application into the vehicle, expectations of a 3-5 dB increase in sound transmission across the frequency band are expected.

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***Fig. 1: Photograph of cymbal panel prior to electroacoustic testing.***



***Fig. 2: Measured transmitting voltage response of cymbal panel.***

## **IMPACT/APPLICATIONS**

The delivery of the second cymbal projector system for the SWAMSI project is on track to be completed in December 2007 when the second electronic drive system is procured, fabricated and tested. The implication of transitioning this transduction technology into SWAMSI will be to provide a lower and broader frequency acoustic output while maintaining broader directivity than is presently being accomplished with the COTs approach. The implementation of the cymbal technology is expected to offer increased performance for the SWAMSI approach.

## **RELATED PROJECTS**

Naval Research Laboratory's Broadband Mine Identification System (BMIS) which uses the original cymbal projector design for a monostatic source.

## **PUBLICATIONS**

J. F. Tressler, T. R. Howarth and D. Huang, "A comparison of the underwater acoustic performance of single crystal vs. piezoelectric ceramic based 'cymbal' projectors," Journal of the Acoustical Society of America, **119** (2), 879-889, 2006. [published, refereed].

D. Huang, T. R. Howarth and K. C. Benjamin, "AUV acoustic array and drive system," UDT Europe 2007 CD Conference Proceedings, Nexus House, Kent, UK, 2007. [published].

J. F. Tressler, R. D. Corsaro, B. H. Houston, T.R. Howarth, "Acoustic performance of LFBB conformal cymbal projectors as a function of depth," Naval Research Laboratory Report NRL/MR/7130-06, 16 Nov 2006. [published].

## **PATENT**

T. R. Howarth, Navy Case Number 98627, Cymbal-module energy harvesting device, April 2007.

## **HONORS/AWARDS/PRIZES**

K. C. Benjamin, NUWC, Mechanical Engineering Lifetime Industry Recognition Award, American Society of Mechanical Engineers (ASME), 22 February 2007.